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Fat Quality and Stability in Dehydrated Proteinaceous Food Mixes

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SUMMARY

The effect of initial quality as determined by peroxide value of rendered chicken fat on the stability of chicken-flavored soup and gravy mix subjected to accelerated storage was determined by oxidation rate studies and by a trained acceptance panel. Both commercially-obtained and laboratory-rendered chicken fats, adjusted to a range of peroxide values from 2 to 10, with and without added antioxidant, were blended with the other components of a standard soup and gravy mix. Oxidation rates of the chicken fats alone were compared with those of the same fats in the soup mix. Rates of chicken fat were affected by added antioxidant, while those in the soup mixes were not.

After 6 months storage at 100°F, peroxide values in unprotected fats ranged from 8 to 71, while those in protected fats were between 6 and 30. When the fats were added to the dry ingredients of the soup and gravy mix, all peroxide values increased initially to a range of 11 to 17. These values decreased during storage at 100°F to about 8 after 6 months and after 1 year to about 4. Panel acceptance of the soups made from these mixes did not change after storage. Hydrolyzed vegetable protein was shown to be responsible for the effects observed.

INTRODUCTION

The current specification, (Dept. of Army 1962) requires a peroxide value not more than 2, which is difficult to procure commercially. This paper reports results obtained during one-year storage at 100°F of twelve prepared dry chicken-flavored soup and gravy bases, each having a chicken fat of different quality. This was done for the purpose of determining the effect of initial peroxide value of chicken fat on the final acceptability of the product.

Our previous work with dehydrated model systems showed that proteinaceous components had a stabilizing action on fat while those of carbohydrate origin had pro-oxidizing effects, (Bishov *et al.* 1960, 1961). Thin layer studies showed that fat oxidation rates were affected by natural antioxidants and synergists such as tocopherol and phospholipids, and their positions in relation to the fat (Togashi *et al.* 1961).

The question of the *relative* importance of the *initial* quality of chicken fat on the acceptability and storage stability of the soup and gravy base was answered in this study by the chemical and taste-test data obtained during the course of storage.

Table 1. Preparation of chicken fat for 100°F storage studies.

Code	Source	Peroxide value: As received	Peroxide value: As used	Antioxidant
N-1	NLABS[a]	0.5	0.5	None
N-2	NLABS	0.5	0.5	0.01% BHA + 0.01% BHT (NLABS)
N-3	NLABS	0.5	3.5	None
N-4	NLABS	0.5	3.5	0.01% BHA + 0.01% BHT (NLABS)
N-5	NLABS	0.5	6.8	None
N-6	NLABS	0.5	6.8	0.01% BHA + 0.01% BHT (NLABS)
M-1	COMM[b]	0.5	0.5	None
M-2	COMM	0.5	0.5	0.01% BHA + 0.01% BHT (NLABS)
W	COMM	2.0	0.5	TENOX-6 0.07% (MFG)
B-1	COMM	2.8	2.8	None
B-2	COMM	2.8	2.8	0.01% BHA + 0.01% BHT (NLABS)
D	COMM	3.5	3.5	None

[a] Laboratory rendered
[b] Purchased from commercial renderer

EXPERIMENTAL

This study consists of two parts: (a) 100°F storage of the dry soup and gravy base containing chicken fat and of the chicken fat alone and (b) accelerated storage at 125°F of chicken fat mixed with selected components.

Preparation of the soup and gravy bases. Twelve dry soup and gravy bases were prepared in the laboratory, six with commercially rendered chicken fat and the other six from chicken depot fat locally purchased and rendered at the Natick Laboratories. After rendering at 200°F, the peroxide value (PV) of this fat was 0.5. The PV of one third of the fat was raised to 3.5 and of another third to 6.8 by aeration of the melted fat at 190°F for 3 and 5 hours, respectively. To half of each of the three fats (PV 0.5, 3.5 and 6.8) antioxidant mixture (0.01% BHT + 0.01% BHA) was added. The other six soups were prepared from rendered fats from commercial sources. One half of each of two of the commercial fats was also stabilized with the same antioxidant, another had Tenox 6[a] added by the manufacturer (Table 1).

Table 2. Composition of soup and gravy base, chicken flavored.

Ingredient	Wt. %
Dried chicken meat	6.0
Monosodium glutamate	12.0
Sucrose	10.0
Onion powder	3.0
Starch	10.0
Hydrolyzed vegetable protein	18.0
Hydrogenated shortening 100 hr (no antioxidant used)	4.4
Turmeric	0.2
Garlic	0.3
White pper	0.1
Salt	31.0
Chicken fat	5.0

The soup and gravy bases were formulated from the chicken fats in accordance with the military specification (Dept. of Army 1962). Table 2 shows the composition of the mix. All ingredients, except the shortening and the chicken fat, were mixed together in one batch. The ingredients were added to the mixer one at a time and mixed for 10 minutes before the addition of the next dry ingredient. The complete mix was divided into 12 equal batches. Shortening and chicken fat were added in small increments while mixing.

Mixing continued for 10 minutes after addition of the fats; the mixing paddle was then scraped clean and mixing resumed for an additional 5 minutes. Uniformity of mixing was achieved; fat determined by extraction of the 12 mixes ranged ±0.15%, about the average. The prepared mixes were air packed in 200 × 300 cans, 7 oz. per can.

[a] Eastman Kodak Company Food Grade Antioxidant. Tenox 6: BHA, BHT, PG, CA, Monoglyc., Corn Oil, and Propylene glycol.

Preparation of selected mixes for accelerated storage. Each chicken fat in petroleum ether solution was mixed separately with dry chicken meat, starch, monosodium glutamate (MSG), hydrolyzed vegetable protein (HVP), onion powder, garlic powder, sugar, and filter paper, to yield when dried, 1 gram of fat to 5 grams of non-fat dry matter, and the solvent was removed by evaporation in a stream of nitrogen. Six grams of each dry mix, containing one gram of chicken fat, were stored in air in a 300 ml reagent bottle sealed with a rubber serum septum.

Storage. Complete soup and gravy bases in cans and the 12 chicken fats alone in screw-cap jars were incubated at 100 ± 1°F. Samples were withdrawn after 3, 6 and 12 months. Headspace gas over the mixes was sampled by puncture of the sealed can. Mixtures of chicken fats with selected dry ingredients were incubated at 125 ± 1°F. Headspace gases were sampled *daily* with a fine needle and gas-tight syringe.

Methods. Headspace gas composition was determined by gas chromatography (Bishov and Henick, 1966). PV of the fats and of chloroform extracts of the mixes was determined by the AOCS iodometric method (AOCS, 1962). All determinations were made on samples of 1 ± 0.1 g of fat; actual weights of fat in the chloroform extracts were determined by evaporation to dryness of an aliquot of the extract. Acceptability was evaluated on a 9-point hedonic scale (Peryam and Pilgrim, 1957) by 10 to 15 member taste panels and difference was indicated in a triangle test (Boggs and Hanson, 1949).

RESULTS AND DISCUSSION

Storage of chicken fat at 100°F in air resulted in increased PV. The rate and extent of the increase, in the absence of added antioxidant, was not related to the initial extent of oxidation (Table 3). Addition of antioxidant markedly inhibited peroxidation of the fat. In one commercially obtained fat, D, for which no antioxidant was claimed on the label, unusual stability was observed. The initial PV's for all fats are those determined at the beginning of the storage study, which was some weeks after the preparation of the fats.

The PV's of the chloroform extracts of the soup mixes were initially higher than those of the fats admixed (Table 3) but declined as storage proceeded. Although PV as measured is known to vary with the sample size taken (Stansby, 1941), the results shown here are internally comparable since in all cases the fat sample was 1 ± 0.1 g. Presence of antioxidant had no apparent effect on PV of the chloroform extracts initially or after storage. This was quite different from the effects on chicken fat alone. Figure 1 shows these effects as averages for unstabilized fats, stabilized fats, soup and gravy bases containing unstabilized fats and containing stabilized fats.

The appearance of CO_2 was observed in the headspace gases of the dry soup and gravy bases (Table 4). The CO_2 formation was traced to hydrolyzed vegetable protein (HVP) by incubation of each dry ingredient at 100°F. Carbon dioxide development from stored HVP was not observed at either 40° or 70°F.

These data suggest that the antioxidant stabilized the bulk fat only. This implies that one or more of the other soup components stabilized the chicken fat in the dry mix. PV of all the soups at the end of one year's storage had reached their lowest levels, decreasing from the initial value of 13 to 4. Stabilizing the chicken fat with BHT + BHA for the soup mix appears to be unnecessary.

Table 3 and Fig. 2 show that the

Table 3. Evaluation during storage at 100°F.

	Peroxide value								Acceptance score			
	A Fat Months				B Soup Months				C Soup Months			
Code	0	3	6	12	0	3	6	12	0	3	6	12
N-1	2.1	11.8	24.5	70.9	13.8	12.5	8.8	3.8	7.1	7.1	6.7	6.9
N-2	1.9	4.8	5.6	6.0	13.6	10.6	8.3	4.0	6.8	6.5	6.2	7.0
N-3	5.3	12.5	17.9	41.3	13.5	10.7	8.6	4.1	6.9	6.8	6.3	7.1
N-4	5.1	6.5	6.8	7.5	12.8	12.0	8.1	3.7	7.1	6.7	6.2	7.1
N-5	10.2	34.7	36.3	36.3	14.7	11.7	8.2	3.8	7.1	6.3	5.9	6.9
N-6	9.7	10.5	9.8	10.5	17.3	10.9	9.1	4.5	6.9	7.0	6.4	6.8
M-1	3.9	23.3	25.7	55.9	11.5	13.5	7.2	3.7	6.7	7.2	6.5	7.1
M-2	4.0	7.5	8.3	10.0	10.9	13.7	8.0	4.8	7.4	7.3	6.3	7.2
W	2.4	8.7	22.4	29.7	11.9	11.7	7.7	3.8	7.0	6.9	6.3	6.9
B-1	4.8	10.5	26.1	56.2	12.8	14.5	8.1	6.7	7.3	7.5	6.3	6.8
B-2	3.5	14.8	16.3	26.9	12.2	12.0	8.7	3.9	7.5	7.0	6.4	7.1
D	3.4	5.8	7.7	8.6	13.2	13.6	7.6	4.0	6.7	7.0	6.5	7.1

Table 4. Headspace gases in chicken soup.[a]

Sample code	3 - mo. Per cent			6 - mo.[b] Per cent			12 - mo.[b] Per cent		
	O_2	CO_2	N_2	O_2	CO_2	N_2	O_2	CO_2	N_2
N-1	15.2	2.4	82.4	24.5	0.9	74.6	18.0	1.6	80.2
N-2	15.6	4.9	79.5	24.3	0.9	74.8	17.3	1.8	80.9
N-3	15.5	4.7	79.8	24.1	0.7	75.2	15.1	1.4	83.5
N-4	14.8	5.1	80.1	25.3	0.9	73.8	18.0	1.3	80.1
N-5	14.9	4.2	80.9	25.4	0.9	73.7	17.5	2.0	80.5
N-6	......	....	......	24.8	0.7	74.5	18.0	1.8	80.2
M-1	14.0	5.5	80.5	23.4	0.8	75.8	18.4	1.0	80.6
M-2	16.0	2.9	83.1	23.8	0.9	75.3	13.8	1.0	85.2
W	18.7	2.6	78.7	23.8	0.7	75.5	13.7	1.3	85.5
B-1	15.7	4.1	80.2	23.1	0.9	76.0	19.0	1.1	79.9
B-2	14.8	4.7	80.5	23.5	0.7	75.8	20.0	1.0	79.0
D	15.3	3.8	80.9	19.4	0.2	78.4	22.0	1.7	76.3

[a] Samples were in air pack
[b] Traces of CO were found in all samples

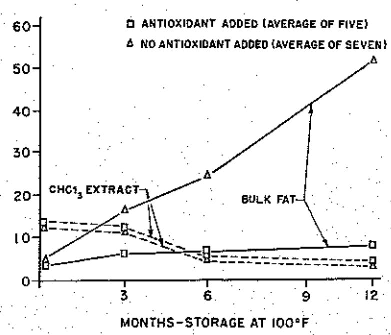

Fig. 1. Effect of storage on average peroxide values in the chicken fats and $CHCl_3$ extracts from chicken soup mix.

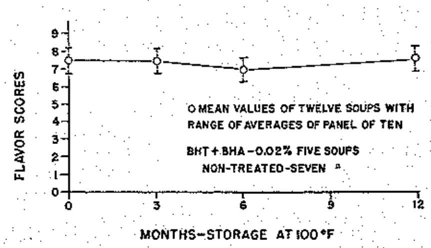

Fig. 2. Flavor scores of dry chicken soup mixes both treated with BHT + BHA 0.02% and the non-treated.

Table 5. Acceptance evaluation of chicken soup mix formulated with chicken of different qualities (panel of 15).

Difference test		Preferences test			
Taster	Different	Taster	1st	2nd	3rd
1	A — B — C	1	B	C	A
2	A — B — C	2	B	C	A
3	A — B — C	3	A	B	C
4	A — B — C	4	B	C	A
5	A — B — C	5	B	C	A
6	B — A — C	6	B	C	A
7	C — A — C	7	B	A	C
8	C — A — B	8	A	B	C
9	B — A — C	9	A	C	B
10	A — B — C	10	B	C	A
11	B — A — C	11	A	C	B
12	A — B — C	12	B	C	A
13	A — B — C	13	B	C	A
14	C — A — B	14	B	A	C
15	A — B — C	15	B	C	A

Difference	Code	Preference 1st	Preference 2nd	Preference 3rd
A — 9	A — Chicken fat P.V. — 50	A — 4	A — 2	A — 9
B — 3	B — Chicken fat P.V. — 25	B — 11	B — 2	B — 2
C — 3	C — Chicken fat P.V. — 1	C — 0	C — 11	C — 4

acceptance scores do not differ among the soup mixes and change very little during storage for one year. A slight decrease in acceptability occurred at the 6-month interval. However, at the end of the storage study the scores were as high as at the beginning.

This study suggests that, in addition to any stabilizing effect which some of the dry-mix components may have on the fat, the high-flavored components, such as garlic and onion powders and HVP, may have a masking effect. To test this, soups were formulated using rancid chicken fats (PV 25 and 50) and fresh chicken fat (PV 1).

A panel of 15 tasted the soups. In a triangle difference test, of the 15 testers, nine picked the chicken soup with fat of PV 50 as different (Table 5). In a preference test of the same soups, no taster preferred the soup formulated with the fresh fat (PV 1). The typical remark was that this soup was too bland. Most testers (11 of the 15), preferred the soup with the fat of PV 25.

The seven active components in the soup mix were studied individually for their stabilizing effects on chicken fat by measuring the rate of oxygen consumption by the mixture. Chicken fats of PV 6.0 and 58 were used. The rate of oxygen consumption in the mixes containing chicken fat of PV 58 was significantly *more* rapid than in those containing fat with the PV of 6 (Fig. 3).

Only HVP appears to have stabilizing action on the fat with PV 58. This further suggests that HVP may be the stabilizing component in the dry soup mixes. Work is in progress to determine which of the components of hydrolyzed vegetable protein is responsible for the stabilizing effects and the mechanism of these effects.

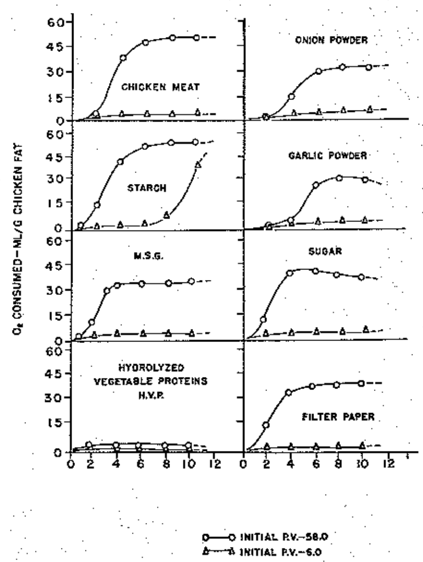

Fig. 3. Effect of some chicken soup mix components on O_2 consumption rate of chicken fat.

CONCLUSIONS

Chicken fat used in formulation of dry soup and gravy base, if of wholesome quality and mild initial flavor, may range in PV from 2 to 10. The dry soup and gravy base is a very stable product and withstands storage of 100°F for a year without significant loss of its original acceptability.

This study suggests the value of an analytical approach to component requirements in dry mix foods used by the armed forces and in the civilian market. Additional studies on factors responsible for fat stability in dry mixes are in progress in our laboratories.

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